CLAIMS

1. A method of operating a series hybrid vehicle having a primary power source and a secondary power source, the method comprising:

selectively generating an amount of primary power from the primary power source;

converting a first portion of the amount of primary power from the primary power source into an amount of direct input energy;

powering the secondary power source directly with the amount of direct input energy;

monitoring an amount of available stored energy within an energy storage device;

generating the amount of primary power from the primary power source when the amount of available stored energy is below a first selected level;

operating an engine at one of a plurality of preselected power levels to generate the amount of primary power; and

selecting the one of the plurality of preselected power levels based on the amount of available stored energy.

2. The method according to claim 1, further comprising:

turning the engine off when the amount of available stored energy is above the first selected level.

3. The method according to claim 1, further comprising:

idling the engine when the amount of available stored energy is above the first selected level.

4. The method according to claim 1, further comprising:

idling the engine when the amount of available stored energy is above the first selected level; and

turning the engine off when the amount of available stored energy is above the first selected level and a command to decelerate the vehicle is issued.

5. The method according to claim 1 wherein the plurality of preselected power levels includes a predefined minimum power level for efficient operation of the engine, and the engine is operated at or near the predefined minimum power level when the amount of available stored energy is within a predetermined range of available stored energy.

6. The method according to claim 1 wherein the plurality of preselected power levels includes a predefined maximum power level for efficient operation of the engine, and the engine is operated at or near the predefined maximum power level when the amount of available stored energy is within a predetermined range of available stored energy.

7. The method according to claim 6 wherein the predetermined range of available stored energy comprises a range at or near complete depletion of the available stored energy.

8. The method according to claim 1 wherein a number of the plurality of preselected power levels reside within a predefined range of power levels for efficient operation of the engine, and the one of the plurality of preselected power levels is within the predefined range of power levels when the amount of available stored energy is within a predetermined range of available stored energy.

9. The method according to claim 8 wherein the one of the plurality of preselected power levels correlates directionally to the power demanded by the vehicle driver.

10. The method according to claim 8 wherein the one of the plurality of preselected power levels is about inversely proportional to the amount of available stored energy within the predetermined range.

11. The method according to claim 1 wherein the engine is comprised of a first and a second engine, the first selected level of available stored energy is higher than each of a second and a third selected level of available stored energy, and the second selected level is higher than the third selected level, the method further comprising:

operating the first engine when the amount of available stored energy is below the first selected level; and

operating the second engine when the amount of available stored energy is either 1) below a second selected level and a command to power the vehicle exceeds a predetermined level of power demand or 2) when the amount of available stored energy is below the third selected level.

12. The method according to claim 11 wherein when the second engine is operated, the one of the plurality of preselected power levels for the first engine is at or near a predefined maximum power level for efficient operation of the first engine and the one of the plurality of preselected power levels for the second engine is at or near one of 1) a power level within a predefined range of power levels that is inversely proportional to the amount of available stored energy within a predetermined range of available stored energy and 2) a predefined maximum power level for efficient operation of the second engine.

13. The method according to claim 1 wherein the primary power source is comprised of a variable displacement engine, the variable displacement engine having a first number of cylinders defining the first engine and a second number of cylinders defining the second engine.

14. The method according to claim 1 wherein the primary power source is either 1) an internal combustion engine, or 2) a Stirling engine.

15. The method according to claim 1, the method further comprising:

based on the amount of available stored energy, selectively powering the secondary power source with either 1) a portion of the amount of available stored energy, 2) a portion of an amount of direct input energy, or 3) a combination of the portion of the amount of available stored energy and the portion of the amount of direct input energy.

16. The method according to claim 15, further comprising:

powering the secondary power source with the portion of the amount of available stored energy, instead of the portion of the amount of direct input energy, when the available stored energy is above the first selected level.

17. The method according to claim 15, further comprising:

powering the secondary power source with the portion of the amount of direct input energy, instead of the portion of the amount of available stored energy, when the available stored energy is either 1) below the first selected level and the amount of direct input energy is sufficient enough to meet a power demand, or 2) below a second selected level.

18. The method according to claim 15, further comprising:

powering the secondary power source with the combination of the portion of the amount of available stored energy and the portion of the amount of direct input energy when the available stored energy is either 1) below the first selected level and above a second selected level, and the amount of direct input energy is not sufficient enough to meet a power demand, or 2) above the second selected level.

19. The method according to claim 1 wherein the primary power source can provide at least 60% to 70% of the desired peak acceleration power level for the vehicle.

20. The method according to claim 1 wherein the energy storage device can efficiently sustain a charge rate matching at least 20% to 25% of the primary power source's maximum rated horsepower.

21. The method according to claim 1 wherein the secondary power source is either 1) an electric motor, or 2) a hydraulic motor.

22. A method of operating a series hybrid vehicle having a primary power source comprised of at least one engine and a secondary power source, the method comprising:

monitoring an amount of available stored energy within an energy storage device;

operating a first engine at or near a first power level when the amount of available stored energy is within a predetermined upper range of available stored energy;

operating the first engine at or near a second power level when the amount of available stored energy is within a predetermined lower range of available stored energy; and

operating the first engine within a range of power levels when the amount of available stored energy is within a predetermined middle range of available stored energy.

23. The method according to claim 22 wherein the first power level is defined by a preselected torque level and a preselected engine speed level, and the first power level is a minimum power level for efficient operation of the first engine.

24. The method according to claim 22 wherein the second power level is defined by a preselected torque level and a preselected engine speed level, and the second power level is a maximum power level for efficient operation of the first engine.

25. The method according to claim 22 wherein the range of power levels comprises a number of power levels, each of the number of power levels corresponding to a preselected torque level and a preselected engine speed level, and each of the number of power levels being higher than the first power level and lower than the second power level.

26. The method according to claim 22, further comprising:

when the amount of available stored energy is within the predetermined middle range of available stored energy, operating the first engine at or near a power level within the range of power levels that is inversely proportional to the amount of available energy within the predetermined middle range of available stored energy.

27. The method according to claim 22 wherein a first selected level of available stored energy is above the predetermined upper range of available stored energy, the method further comprising:

idling the first engine when the amount of available stored energy is above the first selected level.

28. The method according to claim 27 wherein a second selected level is either 1) equal to the first selected level, or 2) below the first selected level, the method further comprising:

re-engaging the first engine, following a command to idle the first engine, when the amount of available stored energy is below the second selected level.

29. The method according to claim 27, further comprising:

turning the first engine off when the amount of available stored energy is above the first selected level and a command to decelerate the vehicle is issued.

30. The method according to claim 27, wherein a second selected level of available stored energy is either 1) equal to the first selected level, or 2) below the first selected level, the method further comprising:

restarting the first engine, following a command to turn the first engine off, when the amount of available stored energy is below the second selected level.

31. The method according to claim 22, further comprising:

selectively operating a second engine, together with the first engine, when the amount of available stored energy is within the predetermined middle range of available stored energy; and

operating the second engine when either 1) the amount of available stored energy is below a selected level within the predetermined middle range of available stored energy, or 2) a command to power the vehicle exceeds a predetermined demand level.

32. The method according to claim 31, further comprising:

when the second engine is operated, operating the first engine at or near the second power level, the second power level being a predefined maximum power level for efficient operation of the first engine; and

operating the second engine at or near either 1) a power level within a predefined range of power levels that is inversely proportional to the amount of available stored energy within the predetermined lower range, or 2) a predefined maximum power level for efficient operation of the second engine.

33. The method according to claim 31 wherein the engine is a variable displacement engine, the variable displacement engine having a first number of cylinders defining the first engine and a second number of cylinders defining the second engine.

34. The method according to claim 22, further comprising:

selectively operating a second engine, together with the first engine, when the amount of available stored energy is within the predetermined lower range of available stored energy; and

operating the second engine when either 1) the amount of available stored energy is below a selected level within the predetermined lower range of available stored energy, or 2) a command to power the vehicle exceeds a predetermined demand level.

35. The method according to claim 22 wherein the engine can provide at least 60% to 70% of the desired peak acceleration power level for the vehicle.

36. The method according to claim 22 wherein the energy storage device can efficiently sustain a charge rate matching at least 20% to 25% of the engine's maximum rated horsepower.

37. The method according to claim 22 wherein the at least one engine is either 1) an internal combustion engine, or 2) a Stirling engine.

38. The method according to claim 22 wherein the energy storage device is either 1) an accumulator, 2) a battery, 3) an ultracapacitor, or 4) a flywheel.

39. The method according to claim 22 wherein the secondary power source is either 1) an electric motor, or 2) a hydraulic motor.

40. A method of powering a secondary power source in a series hybrid vehicle, the method comprising:

monitoring an amount of available stored energy within an energy storage device;

monitoring vehicle speed; and

based on the amount of available stored energy at a given vehicle speed, selectively powering the secondary power source with either 1) a portion of the amount of available stored energy, 2) a portion of an amount of direct input energy, or 3) a combination of the portion of the amount of available stored energy and the portion of the amount of direct input energy.

41. The method of operating a series hybrid vehicle having a primary power source and a secondary power source, the method comprising:

monitoring an amount of available stored energy within an energy storage device;

based on the amount of available stored energy, selectively powering the secondary power source with either 1) a portion of the amount of available stored energy, 2) a portion of an amount of direct input energy, or 3) a combination of the portion of the amount of available stored energy and the portion of the amount of direct input energy;

powering the secondary power source with the portion of the amount of available stored energy when the amount of available stored energy is above a first selected level;

powering the secondary power source with the portion of the amount of direct input energy when the available stored energy is either 1) below the first selected level and the amount of direct input energy is sufficient enough to meet a power demand, or 2) below a second selected level;

powering the secondary power source with the combination of a portion of the amount of available stored energy and a portion of the amount of direct input energy if the available stored energy is either 1) below a first selected level and the amount of direct input energy is not sufficient enough to meet a power demand, or 2) above the second selected level;

using an engine to generate the amount of direct input energy and to generate a first amount of storable energy;

based on the amount of available stored energy, operating the engine at or near one of 1) a first predefined power level when the amount of available stored energy is within a predetermined upper range of stored energy, 2) a second predefined power level when the amount of available stored energy is within a predetermined lower range of stored energy, and 3) a third predefined power level within a range of power levels that is inversely proportional to the amount of available energy within a predetermined middle range of stored energy.

42. The method according to claim 41, wherein the first selected level of available energy is above the predetermined upper range of stored energy, and the second selected level of available energy is below the predetermined lower range of stored energy.

43. The method according to claim 41, wherein the first power level is lower than the second power level, and a respective one of each of the power levels within the range of power levels resides between the first and the second power levels.

44. The method according to claim 41 wherein the second selected level is at or near complete depletion of the available stored energy.

45. The method according to claim 41 wherein the second predefined power level comprises a range of power levels correlating to the power demand.

46. The method according to claim 41 wherein the engine can provide at least 60% to 70% of the desired peak acceleration power level for the vehicle.

47. The method according to claim 41 wherein the energy storage device can efficiently sustain a charge rate matching at least 20% to 25% of the engine's maximum rated horsepower.

48. The method according to claim 41 wherein the engine is either 1) an internal combustion engine, or 2) a Stirling engine.

49. The method according to claim 41 wherein the energy storage device is either 1) an accumulator, 2) a battery, 3) an ultracapacitor, or 4) a flywheel.

50. The method according to claim 41 wherein the secondary power source is either 1) an electric motor, or 2) a hydraulic motor.